

## DIVISION – THERMAL AND MOSITURE PROTECTION

### SECTION 07114

#### HIGH-DENSITY POLYETHYLENE (HDPE) LINING

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. This section covers the work necessary to furnish and install High-Density polyethylene (HDPE) flexible membrane lining, factory-fabricated and field-fabricated boots, complete.
- B. The work includes furnishing all labor, supervision, tools, construction equipment, and materials necessary to install the HDPE lining as shown on the Drawings.

##### 1.2 GENERAL

Unless otherwise specified, the most recent version of the material test standards listed in Part 2 shall apply at the time of bidding.

##### 1.3 SUBMITTALS

Submittals shall be made in accordance with Section 01010 SUMMARY OF WORK, Division 1 - GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:

##### A. Warranties Required:

- 1. Submit a warranty signed by the HDPE lining manufacturer. The warranty shall be against manufacturing defects and workmanship and against deterioration due to ozone, ultraviolet, and other exposure to the elements, for a period of 20 years on a pro rata basis. The warranty shall be limited to replacement of material, and shall not cover installation of a replacement HDPE lining. Warranty form is at the end of this section. The signed manufacturer's warranty shall be submitted seven (7) days prior to material installation.
- 2. Submit warranty signed by the HDPE Lining Installer. The Installer shall warrant the HDPE Lining to be free of defects in material and workmanship for a period of two (2) years following the date of acceptance of the work under this Contract. Repairs shall be made in accordance with these

Contract Documents. Warranty form is at the end of this section. The signed installer's warranty shall be submitted within seven (7) days after installation.

3. No partial or full payment for HDPE LINING installation will be authorized before receipt of signed warranties.

B. Submittals:

1. The CONTRACTOR shall submit complete material specifications, descriptive drawings, and literature.
2. The CONTRACTOR shall submit factory test results of materials certified by the membrane manufacturer as being the same as that delivered to the project and showing conformance with the requirements of these Specifications. In addition, the CONTRACTOR shall submit the manufacturer's certification stating that the material proposed is similar and of the same formulation as material which by actual usage has been demonstrated to be satisfactory for the intended application.
3. The HDPE manufacturer and the installer shall jointly submit for the ENGINEER's approval a complete description of their formal quality control program for fabricating, handling, installing, testing, repairing, and providing a watertight flexible membrane lining. The description shall include, but not be limited to, polymer resin supplier and producer identification, acceptance testing, fabrication production testing, installation testing, documentation of changes, alterations, repairs, retests, and acceptance. The quality control program document shall be submitted for approval by the ENGINEER.
4. The CONTRACTOR shall submit six (6), eight (8) inches by ten (10) inches samples of membrane sheeting, sheeting joints, and seaming and repairing by extrusion welding.
5. Thirty (30) calendar days prior to commencing the work specified under this section, and prior to ordering the membrane material, the CONTRACTOR shall submit to the ENGINEER for approval, Installation Drawings in both hardcopy and AutoCAD 2004 format, procedures, and a schedule for carrying out the work. Installation Drawings shall have membrane lining sheet layout with proposed size, number, position, and sequence of placing of all sheets and indicating the location of all field joints. Installation Drawings shall also show complete details and/or methods for anchoring the membrane at the ends of the liner, making field joints, and making seals around pipes and structures penetrating the membrane.

6. The CONTRACTOR shall make arrangements with the membrane lining manufacturer to allow the ENGINEER to visit the manufacturing plant during the fabrication of panels for this project. CONTRACTOR shall pay all expenses required for ENGINEER'S visit, including travel and lodging (2 individuals maximum). The purpose of the ENGINEER's visit is to observe factory fabrication methods and quality control procedures.
7. The CONTRACTOR shall plan for and include the required tests, submittals, and ENGINEER's visit in the progress schedule.
8. CONTRACTOR shall submit certification that cleaning solvent is compatible with surfaces on which it is to be used.
9. Submit certified test results for angle of friction tests as required in Part 2 of this Section. Submit details of the test including, but not limited to, specimen size, supporting substrate, soil installation method and unit weight, soil moisture at molding and test, rate of strain and normal loads, and test results to ENGINEER prior to shipment of materials represented by the submitted tests to the project site.
10. Manufacturer certification that the personnel and equipment used for installing the materials are approved and meet the requirements of this section.
11. HDPE lining materials delivered to the site shall be inspected for damage, unloaded, and stored with the minimum of handling. Materials shall not be stored directly on the ground. Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated. Materials shall be handled in such a manner as to ensure delivery to the site in sound, undamaged condition.
12. CONTRACTOR shall furnish certified test reports with each shipment of material attesting that the requirements of this Specification have been met. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes.
13. Certification of Subsurface: Prior to HDPE liner installation, submit certification from the HDPE Liner Installer that the surface(s) on which the HDPE liner shall be placed is acceptable, where applicable. Certification shall be made on a duplicate of the form attached at the end of this section. Certification of subgrade shall be made daily for each day when HDPE liner is installed.

## 1.4 MANUFACTURER'S SERVICES

The HDPE lining manufacturer's representative shall inspect the surface on which the HDPE lining is to be placed for acceptability. The representative shall also provide onsite technical supervision and assistance at all times during the installation of the HDPE lining and placement of the overlying fill material. The manufacturer's representative shall furnish the ENGINEER with certification that the HDPE lining was installed in substantial accordance with these Specifications, Drawings, and submittals approved by the ENGINEER.

## PART 2 PRODUCTS

### 2.1 HDPE LINING

- A. The HDPE lining shall consist of textured, first-quality products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes. The HDPE lining shall be an unmodified high-density polyethylene containing no plasticizers, fillers, reclaimed polymers, or extenders, but may contain up to ½ of 1% chemical additives for stabilization against UV light and oxidation damage. Approximately 2 percent carbon black shall be added to the resin for ultraviolet resistance. Textured HDPE lining materials shall be manufactured so that the surface irregularities that produce the required textured surface are completely fused into the sheet or are extruded with the sheet on both sides of the sheet. The minimum membrane thickness required shall be at the thinnest part of the sheet and shall not include the ridges of the rough surface. The minimum lining material thickness required shall be the minimum average roll value (MARV).
- B. The HDPE lining shall be supplied as a single-ply continuous sheet with no factory seams, in rolls which shall have a minimum width of 22 feet. The roll length shall be maximized to provide the largest manageable sheet for the fewest field seams.
- C. Textured HDPE lining materials shall be as manufactured by Poly-Flex, Inc., Grand Prairie, TX, (888) 765-9359; GSE Lining Technology, Inc., Houston, TX, (800) 435-2008; AGRU AMERICA, Inc., Kingwood, TX (800) 373-2478 or approved equal. The HDPE lining installer shall be certified by the manufacturer and approved by the ENGINEER. Physical properties of the textured HDPE lining materials are described in Table 07114-1.

<b>Table 07114-1</b> <b>60 MIL HDPE GEOMEMBRANE PROPERTIES</b>			
<b>Property Requirements</b>	<b>Test Method</b>	<b>Value</b>	<b>Testing Frequency</b>
<i>Physical</i>			
Thickness mils (min. ave.) <ul style="list-style-type: none"> <li>• lowest individual for 8 out of 10 values</li> <li>• lowest individual for any of the 10 values</li> </ul>	D 5994	60 -10% -15%	per roll
Asperity Height mils (min. ave.) <sup>(11)</sup>	GM 12	30	Per roll <sup>(2)</sup>
Density g/ml (max.)	D 1505/ D 792	0.940	200,000 lb
<i>Mechanical</i>			
Tensile Properties <sup>(3)</sup> (min. ave.) <ul style="list-style-type: none"> <li>• yield strength – lb/in.</li> <li>• break strength – lb/in.</li> <li>• yield elongation-%</li> <li>• break elongation - %</li> </ul>	D 6693 Type IV	126 90 12 100	20,000 lb
Tear Resistance – lb (min. ave.)	D 1004	42	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	90	45,000 lb
<i>Endurance</i>			
Stress Crack Resistance <sup>(4)</sup>	D 5397 (App.)	300 hr	Per GRI GM 10
Carbon Black Content - %	D 1603 <sup>(5)</sup>	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note <sup>(6)</sup>	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) <sup>(7)</sup> (a) Standard OIT -- or -- (b) High Pressure OIT	D 3895  D 5885	100  400	200,000 lb
Oven Aging at 85°C <sup>(8)</sup> (a) Standard OIT (min. ave.) - % retained after 90 days -- or -- (b) High Pressure OIT (min. ave.) - % retained after 90 days	D5721 D 3895  D5885	55  80	per formulation
UV Resistance <sup>(9)</sup>  High Pressure OIT (min. ave.) – % retained after 1600 hrs <sup>(10)</sup>	  D 5885	  50	per formulation
<i>Seam Properties</i>			
Shear Strength (Double Hot Wedge Weld and Extrusion Weld) <sup>(11)</sup>	D4437 and GRI GM19 <sup>(12)</sup>	120	See other parts of this Section
Peel Strength (Double Hot Wedge Weld) <sup>(11)</sup>	D4437 and GRI GM19 <sup>(12)</sup>	91	See other parts of this Section
Peel Strength (Extrusion Weld) <sup>(11)</sup>	D4437 and GRI GM19 <sup>(12)</sup>	78	See other parts of this Section
<i>Angle of Friction</i>			
Angle of Friction: Low permeability soil to CDN, min <sup>(13)</sup>	D 5321	25°	1 per 200,000 SF
Angle of Friction: HDPE Liner to CDN, min <sup>(13)</sup>	D 5321	25°	1 per 200,000 SF

Angle of Friction: CDN to Protective Cover Soil Layer, min <sup>(13)</sup>	D 5321	25°	1 per 200,000 SF
<p>(1) Of 10 readings, 8 out of 10 must be <math>\geq 25</math> mils, and lowest individual reading must be <math>\geq 22</math> mils</p> <p>(2) If the asperity height is different on each side of the textured sheet then both sides of the roll shall be tested.</p> <p>(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.</p> <ul style="list-style-type: none"> <li>• Break elongation is calculated using a gage</li> </ul> <p>(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edge of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.</p> <p>(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.</p> <p>(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:</p> <ul style="list-style-type: none"> <li>• 9 in Categories 1 or 2 and 1 in Category 3</li> </ul> <p>(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.</p> <p>(8) Manufacturer shall evaluate samples at 30 and 60 days to compare with the 90 day response. Manufacturer shall submit a report documenting his findings to the ENGINEER.</p> <p>(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.</p> <p>(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.</p> <p>(11) Values listed for shear and peel strengths are for 4 out of 5 test specimens; the 5<sup>th</sup> specimen can be as low as 80% of the listed values.</p> <p>(12) FTB values listed for shear and peel strengths are for 4 out of 5 test specimens at 25%; the 5<sup>th</sup> specimen can be 100% if the strength is no less than 80% of the listed values.</p> <p>(13) Tests shall be performed with site soils compacted and prepared at a moisture content as determined by ENGINEER. Normal loading for friction angle tests shall be: 432 PSF, 720 PSF, 1440 PSF and 2,592 PSF. This is a performance specification. The material will not be accepted if this requirement is not met, regardless of the material's physical properties.</p>			

D. All references to HDPE liner, HDPE lining, HDPE membrane, and HDPE geomembrane in these specifications and on the Drawings, mean the HDPE lining specified herein.

## 2.2 BOOTS

Structures penetrating the membrane shall be sealed to the membrane with factory or field-fabricated boots. Boots shall be made to seal around the structures without folds. The flange portion of the boot shall match the angle of the slope or bottom, be sealed to the membrane, and fit smoothly without excess folds or stretching of the material. The field-fabricated boots shall be made of the same material and workmanship as the membrane, except that smooth membrane shall be used for boots.

## 2.3 EXTRUSION RESIN (EXTRUDATE)

Resin used for fusion welding shall be produced from the same material as the sheet resin. Physical properties shall be the same as the HDPE lining sheets.

## 2.4 PANEL MARKING, PACKAGING, AND STORAGE

Each factory-fabricated sheet shall be given prominent, unique, indelible identifying markings indicating the sheet number, date of fabrication, and proper direction of unrolling and/or unfolding to facilitate layout and positioning in the field. Each factory-fabricated sheet shall be individually packaged in a heavy cardboard and protected to prevent damage to it during shipment, prominently identified in the same fashion as the sheet within, and showing the date of shipment. Until installed, factory-fabricated sheets shall be stored on pallets and shall be protected from the direct rays of the sun under a light-colored heat-reflective opaque cover in a manner that provides a free-flowing air space between the sheets and cover.

## 2.5 SOLVENT

Solvent for cleaning contact surfaces of field joints and for other required uses shall be as recommended by the manufacturer or approved fabricator of the lining material for use on the particular material specified.

## 2.6 NEOPRENE ADHESIVE

All neoprene adhesives used for making required liner connections to concrete shall be of a type or types recommended by the manufacturer or approved fabricator of the neoprene material specified and shall be delivered in original sealed containers each with an indelible label bearing the brand name and complete directions as to proper storage, use, and application of the adhesive.

## 2.7 SEALANT CAULKING

A one-component sealant formulated of butyl rubber and other selected ingredients, equivalent to Biddle Company, St. Louis, MO, Butylgrip Sealant, or as recommended by the manufacturer of the membrane materials.

## 2.8 STAINLESS STEEL CLAMPS

As indicated on the Drawings, clamps shall be used to secure the lining to the pipes that are intended to protrude through the lining. One-half-inch wide clamps shall meet or exceed specifications for "Make-a-Clamp" as manufactured by Breeze Clamp Products Division, Federal Laboratory, Inc., Saltsburg, PA, or equal.

## 2.9 STAINLESS STEEL BATTENS

Stainless steel flat bar or channel shall conform to ASTM A 276, Type 316, Grade A. Flat bars shall be 2-inch wide by 1/4-inch thick if bar or 2-inch wide by 1/8-inch thick if channel.

## 2.10 NEOPRENE RUBBER PADS

As indicated on the Drawings, neoprene rubber shall be used as compression strip beneath boot clamps and battens. One-half-inch thick neoprene rubber shall be 40 to 50 durometer hardness. It shall be cut to a continuous 2-1/2-inch wide piece of neoprene to form the gasket. Neoprene rubber contact cement recommended by the supplier shall be used to bond neoprene rubber in position on surface.

## 2.11 BUTYL MASTIC TAPE

Butyl mastic tape shall be 1/8-inch by 1-1/2-inch with removable paper backing.

## 2.12 RIGID FOAM

Rigid urethane foam board stock, cut to provide a uniform bearing surface over batten strips.

# PART 3 EXECUTION

## 3.1 HDPE LINING INSTALLATION

- A. The HDPE lining shall be installed as shown on the Drawings. The CONTRACTOR shall make necessary field measurements prior to start of fabrication to assure proper fit of the HDPE lining. No HDPE lining material shall be placed when air temperature is less than 35°F and decreasing, or more than 90°F, when relative humidity is more than 80 percent, when it is raining, or when there is frost on the ground. HDPE lining shall not be installed on wet or muddy surfaces. Water shall be controlled at all times in accordance with the provisions of Section 02200 EARTHWORK.
- B. The edges of the HDPE lining shall be anchored as shown on the Drawings, or as otherwise approved in writing by the ENGINEER. The HDPE lining sheeting shall be protected from equipment and other hazards and kept clean and free of all debris during placement. The HDPE lining shall also be protected to prevent uplift by wind or other damage to the membrane prior to seaming, anchoring, or attachment of the edges of the liner.
- C. Installation of the HDPE lining shall be done in a manner which prevents damage to the membrane during and after installation. Protective measures shall include, but not be limited to, the following requirements:
  - 1. Workers on the HDPE lining shall wear smooth-soled shoes. Shoes with patterned or lug soles will not be permitted.
  - 2. Smoking shall be forbidden.

3. Engine-driven equipment used on or near the HDPE lining shall have spark arrestors.
  4. The HDPE lining shall not be used as a fabrication area, a storage area for tools and supplies, or other uses unless specifically approved by the ENGINEER.
  5. Electrical generators or other equipment required for HDPE lining installations shall be operated on protective pads which provide a physical separation between the equipment and the HDPE lining. Equipment which must be moved across the membrane on wheels shall be equipped with smooth tires or wheels which will not damage the membrane. Care shall be taken to prevent sudden stops or changes in direction which could stress or damage the HDPE lining.
- D. The subgrade to be lined shall be smooth and free of vegetation, sticks, roots, broken or sharp rocks greater than 3/4-inch in size, cobbles, debris, and ponded water greater than 1-inch in depth prior to placement of the liner. The liner installer shall inspect the surface and certify in writing to the ENGINEER that the subgrade is acceptable for the proposed liner system. CONTRACTOR is responsible to keep the receiving surfaces in the accepted condition until complete installation of the liner is accomplished.
- E. CONTRACTOR shall not proceed with installation of liner until notified by ENGINEER that condition of subgrade is acceptable and liner installer has so certified.
- F. The CONTRACTOR shall arrange and pay all costs for a representative of the liner manufacturer to be present at the site during liner installation.

### 3.2 HDPE LINING FIELD SEAMS

- A. Lap joints shall be used to seal HDPE lining sheets together in the field. All field joints shall be made on a supporting smooth surface. The lap joints shall be formed by lapping the edges of sheets a minimum of three (3) inches. The contact surfaces of the sheets shall be wiped clean immediately before seaming to remove all dirt, dust, moisture, or other foreign materials, and prepared in accordance with the installer's seaming method approved by the ENGINEER. The lap joints shall extend to the end of the sheets through the anchor trench, boots, and mechanical attachments.
- B. Methods and materials used to hold liner panels or sheets together prior to seaming shall be approved in advance by the ENGINEER.
- C. Field seams may be made using one of two methods: double hot-wedge fusion welding or extrusion welding.

1. If double hot wedge welding is used, the welding machine must allow temperature, welding speed, and pressure to be independently adjusted and have temperature and pressure gauges that measure the wedge surface temperature and bonding pressure. The machine shall produce a double seam with an unwelded strip between the two fused areas forming a channel space that can be tested in accordance with Article FIELD QUALITY CONTROL herein.
  2. If extrusion welding is used, the welding machine shall provide continuous dynamic integration of the extrudate bead with the HDPE lining material. The composition of the extrudate shall be identical to the HDPE lining material. The equipment shall be capable of continuously monitoring and controlling the temperature of the extrudate and the zone of contact where the machine is actually fusing the lining material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.
- D. No "fish-mouths" shall be allowed within the seam area. Where "fish-mouths" occur, the material shall be cut, overlapped, and an overlapping extrusion weld shall be applied. All welds on completion of the work shall be tightly bonded. Any membrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall, as directed by the ENGINEER, be replaced or repaired with an additional piece of HDPE lining and seam tested at no additional cost to the OWNER.
- E. CONTRACTOR shall provide complete documentation regarding the seaming equipment to be used at least 30 calendar days prior to beginning seaming of the HDPE liner. Documentation shall address all requirements in these specifications.

### 3.3 HDPE LINING FIELD TESTING

A. General:

1. Joint test seams shall be made to verify that adequate conditions exist for field seaming to proceed. Each seamer shall produce a test seam at the beginning of each shift. The ENGINEER may require a sample field seam be made at any time during seaming production to verify equipment/operator performance and seam integrity. In addition, if a seaming operation has been suspended for more than 1/2 hour or if a breakdown of the seaming equipment occurs, a test seam shall be produced prior to resumption of seaming operations.
2. After field joints have been made, destructive test samples will be taken from the joints by the CONTRACTOR at a minimum of one sample per 500 feet of field seam or a minimum of one sample per crew each morning and

afternoon. Additional sample locations may be selected by the ENGINEER as deemed necessary. Samples shall have a width of 36 inches and a length of 10 inches plus the seam width, and shall be tested in the field by the CONTRACTOR at the direction of the ENGINEER to determine the peel and tensile strength of the field joint. Every second destructive test seam will be sent by the CONTRACTOR to an independent laboratory approved by the ENGINEER for verification testing. A 10-inch wide portion of each sample shall be retained by the ENGINEER as part of the project record. The cost of quality control testing shall be borne by the CONTRACTOR. Locations where destructive test samples have been removed shall be repaired in accordance with Article REPAIRS TO LINER in this Section and leak tested in accordance with LEAK TESTING herein.

- B. Leak Testing: All field seams and joints shall be tested for weakness and leaks using the vacuum box and soap solution in accordance with ASTM D4437-99. CONTRACTOR shall sequentially test the entire length of each seam using the vacuum box. A sudsy solution consisting of soap and water shall be dispensed on the seam immediately ahead of the vacuum box to enhance the detection of leaks.
- C. If the double hot wedge welding method is used, air pressure testing of the unwelded channel between the two fused areas in each seam may be substituted for the vacuum box test only for those seams that are made using the double hot wedge welding method. Repair seams and penetration boots shall be seamed to the lining using an extrusion process and these seams shall be tested using the vacuum box method specified. Air pressure testing shall be conducted on the entire length of seam. Testing shall be done to demonstrate a pressure of 25 to 30 psig for a period of 5 minutes can be maintained by the seam. If loss of pressure during this time period exceeds 4 psi or does not stabilize, CONTRACTOR shall locate the leak and repair and retest until the seam is acceptable.
- D. Site Test Equipment: The CONTRACTOR shall maintain onsite, in good working order, the following items:
  - 1. Field Tensiometer: The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of 2-inch/min. The tensiometer shall be equipped with a gauge which measures the force in unit pounds exerted between the jaws. Records of all field tests shall be provided for the ENGINEER. The field tensiometer shall be an Accura Lite portable tensile tester as furnished by Columbine International, Ltd., Placerville, CA, or approved equal.
- E. Site Test Equipment: The CONTRACTOR shall maintain onsite, in good working order, the following items:
  - 1. Field Tensiometer: The tensiometer shall be motor driven and have jaws

capable of traveling at a measured rate of 2-inch/min. The tensiometer shall be equipped with a gauge which measures the force in unit pounds exerted between the jaws. Records of all field tests shall be provided for the ENGINEER. The field tensiometer shall be an Accura Lite portable tensile tester as furnished by Columbine International, Ltd., Placerville, CA, or approved equal.

2. Vacuum Box:

- a. The vacuum box shall consist of a rigid housing with a transparent viewing window on top and a soft, close-cell neoprene gasket attached to the bottom of the housing. The housing shall be equipped with a bleed valve. A separate vacuum source shall be connected to the vacuum box such that a negative pressure can be created and maintained inside the box. The vacuum box shall be approved by the ENGINEER.
- b. Alternate test procedures shall be submitted for approval to the ENGINEER. All testing methods shall be submitted to the ENGINEER for approval prior to commencement of testing.

3.4 REPAIRS TO HDPE LINER

Any necessary repair to the HDPE lining shall be made with a piece of the HDPE lining material. The patch size shall be 4 inches larger in all directions than the areas to be repaired. All corners of the patch shall be rounded with a minimum radius of 1 inch. The contact surfaces shall be prepared and the patch joined to the membrane and the edges extrusion welded in accordance with Article FIELD SEAMS.

3.5 QUALITY OF HDPE LINING WORKMANSHIP

All joints, on completion of work, shall be tightly bonded and watertight. The word "watertight" shall be defined as impermeable to the passage of water in a liquid state and the solid and liquid phases of the waste to be stored in the landfill. Any HDPE lining surface showing injury due to scuffing, penetration by foreign objects or distress from rough subgrade shall be replaced or covered and sealed with an additional layer of HDPE lining material of the proper size, at the CONTRACTOR's sole expense. No backfill shall be placed on the liner until all seams have been tested and accepted by the ENGINEER.

3.6 CONNECTIONS OF HDPE LINING TO CONCRETE

- A. Anchors and other materials by which the HDPE lining will be attached to concrete structures shall be installed as shown on the Drawings, or as otherwise approved by the ENGINEER. Seams, cuts, or other inconsistencies in lining materials shall be extrusion welded and prepared in such a manner as to provide a smooth, watertight seal when the lining is fastened to them.

- B. Concrete surfaces to which the lining is to be attached, or in contact with, shall be ground smooth using suitable grinding equipment. All fins and protrusions shall be removed.
- C. The HDPE lining shall be mechanically attached to concrete structures as shown on the Drawings. Neoprene rubber pads shall be installed below all battens, washers, and clamps to prevent damage to the underlying HDPE lining. Anchor bolt nuts and clamps shall be tightened sufficiently, but not more, to deform the neoprene rubber pads uniformly to obtain a watertight connection to the concrete surface. No wrinkles shall exist in the HDPE lining at the location of battens, clamps, washers, or at other locations along the mechanical connection.
- D. Once mechanical connections have been made, the edge of the HDPE lining shall be continuously welded to the lining materials to form a watertight seal. Cap strips shall be installed as shown on the Drawings, or as otherwise directed by the ENGINEER.

### 3.7 HDPE LINER BOOTS

- A. Tightly fitting factory or field-fabricated boots shall be installed around pipe penetrations through the lining at locations shown on the Drawings. Care shall be taken to prevent the formation of folds or wrinkles in the boot. Butyl mastic tape shall be installed between the pipe and the boot at the location where the boot clamp will be installed.
- B. The base of the boot shall be fastened or extrusion welded to the HDPE lining.
- C. The boot shall be fastened to the pipe using a stainless steel clamp with a neoprene rubber pad and continuously extrusion-welded with copper wire. Care shall be taken to prevent the formation of folds or wrinkles in the boot. Where the penetrating pipe consists of HDPE material, the top of the boot shall be continuously welded to the pipe to form a final seal.

### 3.8 HDPE LINING RECORD DRAWING

The CONTRACTOR shall provide final Record Drawings to show any changes from the approved Installation Drawings in both hardcopy and AutoCAD 2004 format at no cost to the OWNER. The Record Drawings shall include the identification and location of all repairs, cap strips, penetrations, and areas selected for destructive test samples. The Record Drawing shall be at a scale of 1"=50 feet and shall be submitted to the ENGINEER within 48 hours of the completion of the installation of the HDPE Lining.

### 3.9 HDPE LINING QUALITY CONTROL RECORD DOCUMENT

The CONTRACTOR shall provide copies of all material test results, seam test results, repair logs and document any changes approved by the ENGINEER.

### 3.10 PLACEMENT OF OVERLYING LAYERS

Refer to Section 02273 CDN, Division 2 - SITE WORK, for details on placing overlying layers of synthetic or earth materials on the HDPE lining. The liner shall not be covered until it has been accepted by the ENGINEER. A qualified representative of the HDPE Lining Subcontractor shall be available during placement of overlying layers of materials to make any repairs necessary to the HDPE lining.

### 3.11 CLEANING

After completion of the liner installation, the CONTRACTOR shall remove all debris, trash, soil, mud, and other objects from the surface of the liner system prior to installation of the overlying layers.

(Forms attached)

**HDPE LINER INSTALLER'S CERTIFICATION OF  
SUBSURFACE ACCEPTABILITY**

The HDPE Liner Installer for the project, \_\_\_\_\_,  
hereby certifies that the supporting surfaces are acceptable for installation of the HDPE lining,  
the undersigned having personally inspected the condition of the prepared surfaces. This  
certification is for the areas defined as follows:

The condition of the supporting surfaces in the defined area meets or exceeds the minimum  
requirements for installation of the HDPE Lining.

Signed: \_\_\_\_\_  
(Representative of HDPE Lining Installer)

\_\_\_\_\_  
(Position)

Date: \_\_\_\_\_

Witness: \_\_\_\_\_

Date: \_\_\_\_\_

## HDPE INSTALLATION WARRANTY

Project: \_\_\_\_\_

OWNER: \_\_\_\_\_

Location of Installation: \_\_\_\_\_

Effective Date: \_\_\_\_\_

The HDPE Installer, \_\_\_\_\_, warrants to the OWNER, the HDPE material installed for this project to be free from defects in material and workmanship for a period of two (2) years following the date of acceptance of work under this Contract. This warranty covers repair or replacement of such defective material and workmanship. Repairs made under this warranty shall be made in accordance with these Contract Documents.

Repairs made to the HDPE under this warranty shall be warranted for a period of two (2) years from the date of repair.

\_\_\_\_\_  
HDPE Installer

\_\_\_\_\_  
Authorized Representative's Signature

\_\_\_\_\_  
Authorized Representative's Printed Name and Position

\_\_\_\_\_  
Date

## HDPE MATERIAL WARRANTY

Project: \_\_\_\_\_

OWNER: \_\_\_\_\_

Location of Installation: \_\_\_\_\_

Effective Date: \_\_\_\_\_

The HDPE Manufacturer, \_\_\_\_\_, warrants to the OWNER, the HDPE material manufactured for this project to be free from manufacturing defects and workmanship, to be able to withstand exposure to ozone, ultraviolet, and other natural elements, and the intended use from the effective date for a period of twenty (20) years, on a pro rata basis. Repairs made to the HDPE under this warranty shall be made in accordance with these Contract Documents.

Repairs made to the HDPE under this warranty shall be warranted for a period of two (2) years from the date of repair.

This warranty does not cover installation of a replacement HDPE.

\_\_\_\_\_  
HDPE Manufacturer

\_\_\_\_\_  
Authorized Representative's Signature

\_\_\_\_\_  
Authorized Representative's Printed Name and Position

\_\_\_\_\_  
Date

**PART 4      PAYMENT**

- A.      Payment for HDPE lining repairs as called for on the plans will included in the Contractor's Lump Sum Bid Price.

**END OF SECTION**